R E P O R T R E S U M E S

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THE REASONING METHODS AND REASONING ABILITY IN NORMAL AND MENTALLY RETARDED GIRLS AND THE REASONING ABILITY OF NORMAL AND MENTALLY RETARDED BOYS AND GIRLS.

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DESCRIPTORS- *MENTAL RETARDATION, *RETARDED CHILDREN, *THOUGHT PROCESSES, *LEARNING ACTIVITIES, *EDUCABLE MENTALLY HANDICAPPED, ELEMENTARY SCHOOL STUDENTS, PUBLIC SCHOOLS, COMPARATIVE ANALYSIS, INSTITUTIONAL ENVIRONMENT, SYRACUSE, NEW YORK, SPRA PRIMARY MENTAL ABILITIES TEST, SORTING TEST

A STUDY WAS MADE TO ESTABLISH AND ANALYZE THE METHODS OF SOLVING INDUCTIVE REASONING PROBLEMS BY MENTALLY RETARDED CHILDREN. THE MAJOR OBJECTIVES WERE--(1) TO EXPLORE AND DESCRIBE REASONING IN MENTALLY RETARDED CHILDREN, (2) TO COMPARE THEIR METHODS WITH THOSE UTILIZED BY NORMAL CHILDREN OF APPROXIMATELY THE SAME MENTAL AGE, (3) TO EXPLORE THE INFLUENCE OF LEVELS OF ABSTRACTNESS ON REASONING ABILITY IN THE MENTALLY RETARDED, (4) TO COMPARE THESE RESULTS WITH THOSE OBTAINED ON NORMAL CHILDREN OF SIMILAR AGE LEVELS, AND (5) TO DETERMINE THE DIFFERENCES IN REASONING ABILITIES BETWEEN MALE AND FEMALE MENTAL RETARDATES. A GROUP OF 50 EDUCABLE MENTALLY HANDICAPPED SUBJECTS RANGING IN MENTAL AGE FROM 8 TO 11 YEARS WERE SELECTED FROM THE POPULATION OF SYRACUSE STATE SCHOOL, OMITTING CHILDREN WITH GROSS PHYSICAL OR EMOTIONAL HANDICAPS. COMPARABLE GROUPS OF MENTALLY NORMAL CHILDREN WITH APPROXIMATELY THE SAME MENTAL AGE LEVELS WERE SELECTED FROM THE PUBLIC SCHOOL POPULATION. EXPERIMENTAL AND CONTROL GROUPS WERE ADMINISTERED A SERIES OF THREE REASONING TESTS. ADDITIONAL DATA WERE COLLECTED BY THE DETERMINATION OF THE TYPES OF PROBLEM-SOLVING TECHNIQUES UTILIZED BY THE SUBJECTS. DATA WERE EVALUATED BY AN ANALYSIS OF VARIANCE. QUALITATIVE ANALYSIS WAS MADE IN TERMS OF THE METHODOLOGIES USED BY THE SUBJECTS IN REASONING TESTS. IN THE COMPARISON OF REASONING ABILITY THE TOTAL NORMAL AND RETARDED GROUPS DID NOT DIFFER SIGNIFICANTLY IN REGARD TO THEIR MENTAL AGE. SOME DIFFERENCES WERE FOUND WHEN AN ANALYSIS WAS MADE OF THE SUBGROUPS OF BOYS AND GIRLS. THE RETARDED BOYS SCORED LOWER THAN THE NORMAL BOYS BUT FOR THE NORMAL AND RETARDED GIRLS NO SIGNIFICANT DIFFERENCES WERE FOUND. (AH)

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An Investigation of

1. THE REASONING METHODS AND REASONING ABILITY IN NORMAL AND MENTALLY RETARDED GIRLS

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2. THE REASONING ABILITY OF NORMAL AND MENTALLY RETARDED BOYS AND GIRLS

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CHAPTER I

INTRODUCTION

Educators, in developing a curriculum, must take into consideration many factors if it is to be designed to meet the needs of individual children. Among those factors of primary importance are the potentialities and characteristics of specific children enrolled within the total school environment. Thus, a curriculum cannot be established on such isolated factors as mental age, previous school and community experiences, the potentials of a child, or the social objectives of the educator. All of these must be taken into consideration. Specifically, for mentally retarded children, the factor of mental age is not enough for the prediction of future success in academic performance since learning characteristics have never been demonstrated to have a direct and consistent relationship to this factor.

To set up a logically consistent curriculum for the retarded, it is necessary to:

1. determine the nature of their learning characteristics,
2. compare their performance with normal groups of
   a. similar mental age
   b. similar chronological age.

Prohibitions of time and funds do not permit a complete investigation into all areas of learning; individual learning principles must be selected.

The first purpose of this study was to investigate some reasoning processes and reasoning abilities as well as the influence of levels of abstraction on reasoning ability of female mentally retarded and normal children. Comparisons were made among

1. educable mentally retarded,
2. normal children of approximately the same mental age,
3. normal children of approximately the same chronological age.

A second purpose of the study was to investigate the comparative reasoning abilities of

1. educable mentally retarded with normal children (boys and girls) of the same mental age,
2. normal boys with normal girls of the same mental age,
3. educable mentally retarded boys with educable mentally retarded girls of the same mental age.

CHAPTER II

REVIEW OF THE LITERATURE AND HYPOTHESES

In an examination of the research previously concerned with certain aspects of learning behavior in the mentally retarded, results and conclusions of several studies which are of relevance to this project were selected and are discussed herein. The bulk of the reported material is concerned with either exploratory studies with the retarded or comparisons of normal and retarded children of similar mental ages.

Exploratory Studies

Several investigators have concerned themselves with an exploration of the learning behavior of retarded individuals for varying aspects of learning: the effectiveness of rote learning, the amount and consistency of learning *transfer*, *practice effect*, and the role of motivation. McCulloch, Reswick, and Irving (15) attempted to analyze the relationships of chronological age and mental age with performance on a verbal task which involved trial and error and repetitive learning. They concluded that their results supported the over-all relationship between mental age and performance on a learning task but noted that this correlation was not maintained when the task was subdivided into its two principal components of grasp and repetitive learning. Similarly, Ordahl and Ordahl (19), from their data collected on 30 retarded individuals

on a series of color cue tasks, concluded that the complexity of the material and the rate at which it is acquired have a direct relationship to mental age.

In an attempt to determine practice effects and to measure the amount of transfer of training to a similar task, Tizard and Loos (24) found that mentally retarded subjects exhibited successive gains with practice and on subsequent tasks. Using the Minnesota Spatial Relations Test, they concluded that practice, of a relatively small amount, even when followed by an interval of one month without practice, made it possible for low grade retardates to perform a complicated task as well as, or, in some cases, better than the normal, untrained adult. They observed, as did Ward (25), that transfer of training had also taken place. In specifically studying the sequence of the learning exhibited, they identified several stages: general response, perseverative behavior, trial and error, general spatial orientation.

Aldrich and Doll (1) found positive effects of practice in terms of time required on successive tasks. In their study of the performance of 88 retarded subjects in repetitively presented problem situations, they found little relationship between learning and mental age above the mental age of 2-0. They suggested, as did McCulloch, Reswick, Irving, and Gardner (15), that motivation plays a prominent role in problem situations which are repetitively presented. In a study similar to their above-mentioned investigation, but with a smaller number of retarded subjects, Doll and Aldrich (8)

found no consistent relationship between learning and mental age and further noted that an initial positive relationship decreased with successive trials.

From this cursory review it is evident that there are discrepancies in the findings and conclusions of the exploratory studies reported thus far.

Comparisons of Normal and Retarded Individuals

Several investigators have attempted to study quantitative and qualitative differences in reasoning ability between retarded and normal individuals grouped or matched according to the criterion of mental age.

Woodrow (27), in an extensive study of learning and transfer, observed that both normal and retarded subjects showed improvement with practice but did not differ significantly in the extent of this improvement.

Colvin (4) investigated differences between normal and subnormal children on learning curves obtained by performance on a cancellation task, utilizing 5 normal subjects matched in mental age with 5 subnormals. In all cases the normal subject of each pair made greater improvement and did so with less variability than the subnormal subject. A second aspect of Colvin's study involved an investigation of speed of transfer with a modification of the cancellation task using one pair of subjects. The subnormal child demonstrated a greater degree of transfer than the normal subject. This behavior was interpreted as being due to a greater degree of carry-over in

attending and discriminating by the subnormal, as compared with the normal subject. It should be emphasized, however, that only one normal and one subnormal were tested in this phase of the investigation.

A number of investigators have considered the relative academic achievement of normal and retarded individuals of similar mental ages. In studying achievement on standardized arithmetic tests, Jones (13), Merrill (17), Dunn (9), and Cruickshank (5) found that the retarded and normal subjects did not differ significantly in arithmetic computation. However, when the results of arithmetic reasoning tests were scrutinized, Cruickshank and Dunn noted that the normal subjects surpassed their retarded counterparts.

Cruickshank (5), who undertook an exhaustive breakdown of the components of the arithmetic process, indicated that normal subjects were significantly superior to the retarded in: ability to solve abstract and verbal problems; ability to solve concrete problems in each of the four fundamental operations, understanding of the operation required in the solution of an arithmetic problem, isolating needed arithmetic facets from a void of extraneous information, solution and explanation of practical situations containing commonly encountered arithmetic terms and phrases; arithmetic vocabulary; and maturity of number comprehension.

In another approach dealing with normal and retarded subjects of comparable mental ages, Merrill (17) compared retarded subjects to the test norms for children in the standardization population

(Revised Stanford-Binet) who had chronological ages comparable to the mental age level of the retarded. She found that in arithmetic, reading, and spelling there were no significant differences between the over-all scores obtained by the two groups.

Conversely, on other tests, Murdoch (18) observed that retarded subjects exceeded the norms in varying degrees; however, she did not evaluate these differences statistically.

Thompson and Magaret (23), in analyzing the performance of normal and retarded individuals on the items on the 1937 Revision of the Stanford-Binet Scale, identified 60 test items which discriminated at a high level of probability between superior, normal, and retarded subjects. The retarded individuals performed more adequately on tasks necessitating manual manipulation rather than those requiring totally verbal responses and those employing the use of test materials in deference to verbal presentation. They also noted that the retarded subjects did more poorly on items involving rote memory.

In quantitative studies on other standardized psychometric tests, retarded subjects surpassed their normal mental age group counterparts in: non-language tests (6, 13, 22); tests involving motor manipulation of material (13, 22); and digit symbol substitution tests (3, 10). Conversely, normal subjects were superior in: word association tests (10, 13, 22); picture, word, and sentence completion tests (6, 10); and tests of attention and immediate memory (10, 13, 22).

Hypotheses

The following hypotheses were tested, using only girls:

H_1: There are significant differences among the performances of Retarded Girls, Normal Girls of the Same Mental Age, and Normal Girls of the Same Chronological Age on the Sorting Test of reasoning ability.

a. The Normal Chronological Age girls perform higher than either the Retarded or the Normal Mental Age girls.

b. There are no differences in the performance of the Retarded and the Normal Mental Age girls.

H_2: On the Sorting Test, the subgroups representing all three populations (Retarded, Normal Mental Age, and Normal Chronological Age), which receive the simple task first, score significantly higher on the complex task than will the corresponding subgroups presented with the complex task initially.

H_3: On the Dearborn Form Board, the three groups of girls: Retarded, Normal Mental Age, and Normal Chronological Age, demonstrate statistically significant differences in performance.

The following hypotheses were tested using normal and educable retarded heterosexual groups:

H_4: On the SRA Primary Mental Abilities Test (Reasoning), there will be no observable differences between the performance of Normal and Educable Retarded Children of the same mental ages.

H_5: On the SRA Primary Mental Abilities Test (Reasoning), there will be no observable differences between the performances of Normal boys and Normal girls of the same mental ages.

H_6: On the SRA Primary Mental Abilities Test (Reasoning), there will be no observable differences between the performances of Educable Retarded boys and Educable Retarded girls of the same mental ages.

CHAPTER III

PROCEDURE

Subjects

Fifty female Mentally Retarded subjects with intelligence quotients ranging from 50 to 75,mental ages 7-6 to 12-0, and chronological ages 16-0 to 18-0, were used as the Retarded group in testing the first three hypotheses. These subjects were selected at random from the Syracuse State School, Syracuse, New York. The Normal Mental Age group consisted of 50 female subjects with intelligence quotients ranging from 90-110, mental ages 8-0 to 12-2, and chronological ages 8-6 to 13-0, randomly selected from four Syracuse Public Schools, grades 3 through 6. The Normal Chronological Age group consisted of 50 female subjects with intelligence quotients ranging from 90-110, mental ages 14-0 to 16-6, and chronoligical ages 16-0 to 18-0. These subjects were obtained by random selection from one Syracuse Public High School. All subjects were white, native Americans. The test used for obtaining mental ages for the retarded children was the 1937 Revision of the Stanford-Binet, Form L. The test used for selection and establishment of mental ages for both groups of normal girls was the California Test of Mental Maturity.

Thirty educable retarded subjects (15 boys and 15 girls) with intelligence quotients ranging from 61 to 78, mental ages ranging from 9-4 to 10-11, and chronological ages ranging from 11-3 to 16-11 were

used as the Retarded group in testing the last three hypotheses. These subjects were selected from special classes in the Schenectady and Liverpool Public Schools. The Normal Mental Age group consisted of 30 subjects (15 boys and 15 girls) with intelligence quotients ranging from 80 to 119, mental ages ranging from 7-10 to 10-4, and chronological ages ranging from 8-6 to 11-0 selected from regular grades in the East Syracuse Public Schools. The test used for selection and establishment of mental ages was the 1937 Revision of the Stanford-Binet, Form L.

The Total Normal and Retarded Group, Normal and Retarded Boys, Normal and Retarded Girls, Normal Boys and Girls, and Retarded Boys and Girls were equated for mental age, Table I. Snedcor t and F-tests were applied to the data to determine whether there were any significant differences between the groups. In no instance did the difference between the means approach significance. The differences between the means varied from 0.00 months (between Normal and Retarded Boys) to 1.34 months (between Normal and Retarded Girls).

Instrumentation

Four tests of reasoning ability were administered individually and required approximately 1 hour testing time. The four tests utilized were:

1. Sorting,
2. Squares,
3. Dearborn Form Board,
4. SRA Primary Mental Abilities Test.

TABLE I

MEAN MENTAL AGES AND STANDARD DEVIATIONS FOR TOTAL, BOYS, AND GIRLS - NORMAL AND RETARDED GROUPS

GROUP	N	M (months)	σ	D/Means	t	PROBABILITY
Total Normal	30	111.40	8.03			
Total Retarded	30	110.73	10.18	0.67	1.50	>.05
Normal Boys	15	111.33	8.47			
Retarded Boys	15	111.33	12.22	0.00	0.00	>.05
Normal Girls	15	111.47	7.40			
Retarded Girls	15	110.13	7.56	1.34	0.95	>.05
Normal Boys	15	111.33	8.47			
Normal Girls	15	111.47	7.40	0.14	0.06	>.05
Retarded Boys	15	111.33	12.22			
Retarded Girls	15	110.13	7.56	1.20	0.63	>.05

Sorting Test[1]

This test was designed after the Vigotsky and involved the sorting of 9 objects. Eight separate sorting concepts were incorporated into these objects: shape, color, edging, texture, height, symbol shape, symbol color, and symbol location. A simplified form of the test was used utilizing 3 objects per concept. It also allowed for the presentation of each of the 8 concepts separately. Two forms, a simple and a complex (using the 9 blocks), were administered to all subjects.

All three groups, the Retarded, Normal Mental Age, and Normal Chronological Age, were separated randomly into two subgroups of 25 subjects each. In each case, the 25 subjects representing their respective group were presented the simple concepts first, followed by the complex set. The other subgroup of 25 subjects from each group was given the complex set of concepts, followed by the simple set. This method was utilized to determine the influence of levels of abstraction upon reasoning behavior.

When the subjects were given the simple set of concepts, presented singly, the testees were asked to explain in what way the 3 objects were alike. A reasonable amount of time was allowed for an answer.

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[1] This test was created by Dr. Chalmers L. Stacey, Associate Professor of Psychology, Syracuse University, Syracuse, New York.

When the subjects were given the complex set of concepts, the examiner requested the subject to sort the 9 objects into three groups of 3 blocks each, using an identifying characteristic which would make each group alike, or consistent within itself. The possible solutions were 8 in number: shape, color edging, texture, height, symbol shape, symbol color, and symbol location. After a solution was reached, the objects were replaced in their original pattern of presentation and the subject was asked to continue sorting them using a new classificatory system each time. The test was ended when the subject reached the point of self-recognized realization that further kinds of solutions were impossible. There were no established time limits for this test, nor were the subjects informed that there were 8 correct solutions possible.

The score was computed by noting the total number of simple and complex concepts that were solved correctly. A record of the order of solution was kept for the complex concepts, indicating which was solved first, second, and so on, through as many concepts as were obtained by any one subject.

Squares Test[1]

The task required of the subjects on this test was a fitting together of specially cut pieces of masonite to form 5 individual

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[1] This test was created by Dr. Chalmers L. Stacey, Associate Professor of Psychology, Syracuse University, Syracuse, New York.

squares; each square measuring 5 inches by 5 inches. There were 20 pieces in all, designed so that there was only one possible solution for the completion of the 5 separate squares. Each square required 4 pieces.

In the administration of this test, a model square, 5 inches by 5 inches, was placed before the subject. He was allowed to use this model in any way he saw fit in building the squares. First, the 4 pieces of square A were presented and the subject was asked to build a square of the same size as the model. When square A was completed, the pieces were retrieved by the examiner. Next, 4 pieces comprising square B were added to the original 4 pieces and presented. Thus, the subject had 8 pieces and he was requested to build 2 separate squares, each the same size as the model. This additive process was carried through square E, or as long as the subject succeeded. The final test consisted of 20 pieces given simultaneously with the request to build 5 separate squares.

A time record was kept for the solution of each square, with an over-all time limit of 45 minutes for the completion of all 5 squares. If the subject failed to complete all the steps within the time limit, or gave up at any point, the score was recorded to the last fully completed step. The steps were square A, square A plus B, square A plus B plus C, square A plus B plus C plus D, and square A plus B plus C plus D plus E.

Dearborn Form Board

On this test, the subject was presented with a series of 8 different form boards in sequence. Each form board required a specific number of pieces of varied shapes to complete successfully the prearranged open spaces. The shapes of the pieces to be fitted into the board varied: squares, circles, semicircles, triangles, and pieces with U-shaped openings. Each successive problem-board presented an increasing number of open spaces to be filled by the subject. Boards 1 through 8 were given individually, with the omitted pieces placed next to the board. The examiner requested the subjects to place the pieces into the board in a minimum amount of moves; the result being an accurately completed formboard. The subjects were told that the pieces were interchangeable throughout the board. Thus, through manipulation of the pieces, spaces could be opened to allow for inclusion of all the shapes outside the board. The subjects were instructed to plan their moves ahead so as to complete the board in a minimum amount of moves. Prior to administration of the main part of the test, a practice test was given to acquaint the subjects with the requirements. No time limit was placed on this test; the subjects were allowed to complete each board.

Scoring was determined by the total number of correct solutions per formboard, and the total number of moves for items 1 through 4, 1 through 5, 1 through 6, 1 through 7, and 1 through 8.

SRA Primary Mental Abilities Test

The SRA Primary Mental Abilities Test was administered to both the Normal and Retarded subjects and scored according to published standardization. The Reasoning sections, R_w (Reasoning-Words) and R_f (Reasoning-Form), were used to compare the reasoning abilities of the various groups.

Statistical Analyses

To determine the differences in performance among the three groups (Retarded, Normal Mental Age and Normal Chronological Age) on the Sorting Test, a factorial design (3 x 2 x 2) was utilized. This design provided for an analysis of the differences between groups, tasks (simple versus complex), and orders (simple first or complex first) with supplemental interactions.

For the results of the Dearborn Form Board, the subgroups (single first and complex first) were combined and a single classification analysis of variance (3 groups) was computed.

Additional t- and F-tests were applied to the data resulting from the Simple task first and Complex task second subgroups, and the scores of the Complex first and Simple second for the Retarded and Normal Mental Age populations. Further analyses were computed utilizing the separate subgroups within the Retarded and Normal Mental Age populations, respectively.

No statistical procedures are listed for the Squares Test as there was a contamination of results due to inconsistencies in administration procedure (see Results chapter).

Snedcor t- and F-tests were applied to the data obtained from the Reasoning sections of the SRA Primary Mental Abilities Test since the groups being tested had been equated on the basis of mental age, Table I.

CHAPTER IV

RESULTS

The first findings presented in this chapter are based upon the results obtained on two tests (Sorting Test and Dearborn Form Board) by three groups of subjects:

1. 50 Educable Mentally Retarded Girls,
2. 50 Normal Girls of equivalent Mental Age levels,
3. 50 Normal Girls with Chronological Ages similar to the Retarded population (see Table II).

The third test originally under consideration (Squares Test) was dropped because the results were contaminated by discrepancies in procedure. As a guarantee against the discarding of significant findings, a scattergram was plotted using the results of the Normal Mental Age group on the Squares Test and the Reasoning factors of the SRA Primary Mental Abilities Test. The resulting configuration demonstrated practically no correlation between the Squares Test and any of the three measures of Reasoning ability. Similar scattergrams using the data collected on the Sorting Test and the Dearborn Form Board yielded positive correlations--the Sorting Test apparently measuring most proficiently what is labeled "Reasoning" by the criterion test (SRA Primary Mental Abilities). In view of these findings, the elimination of the Squares Test from the battery should not essentially alter the results nor the discussion of the data collected.

TABLE II

MENTAL AGE AND CHRONOLOGICAL AGE DATA FOR RETARDED, NORMAL MENTAL AGE, AND NORMAL CHRONOLOGICAL AGE GROUPS

Variable		Retarded (N = 50)		Normal Mental Age (N = 50)		Normal Chronological Age (N = 50)	
		S_1	C_1	S_1	C_1	S_1	C_1
Number		25	25	25	25	25	25
Mean	Mental age	10-0	9-10	10-3	9-11	15-5	14-11
	Chronological age	17-3	17-3	10-6	10-5	16-11	16-7
Range	Mental age	7-6 - 11-10	8-5 - 11-8	8-3 - 11-10	7-11 - 12-2	14-3 - 16-6	14-2 - 16-5
	Chronological age	16-1 - 17-9	16-7 - 17-10	8-6 - 12-4	8-7 - 13-0	16-0 - 17-7	16-0 - 17-7
Total Means	Mental age	9-11		10-1		15-2	
	Chronological age	17-3		10-6		16-9	
Ranges	Mental Age	7-6 - 11-10		7-11 - 12-2		14-2 - 16-6	
	Chronological age	16-1 - 17-10		8-6 - 13-0		16-0 - 17-7	

Findings obtained from the Reasoning sections of the SRA Primary Mental Abilities Test are also presented for the following groups of subjects of equivalent mental ages:

1. 30 Normal children
   a. 15 Normal Boys
   b. 15 Normal Girls
2. 30 Educable Mentally Retarded children
   a. 15 Retarded Boys
   b. 15 Retarded Girls

The results are given in the order of the hypotheses as presented.

1. Analysis by Lindquist's type III factorial design demonstrates a statistically significant difference (.001 level of confidence) in the performance of the three groups on the Sorting Test (see Table III). These results support Hypothesis 1, that there will be a significant difference in the scores of the Retarded, Normal Mental Age, and Normal Chronological Age girls on this test of reasoning ability. Figure 1 demonstrates graphically the mean scores obtained by the three groups on the Sorting Test.
   a. The results are in keeping with Hypothesis 1a, that the Normal Chronological Age girls will perform highest on this task.
   b. Hypothesis 1b, that there would be no differences in the performance of the Retarded and Normal Mental Age girls, cannot be accepted. Significant differences (.01 level) in favor of the Retarded group were found on the Complex task (see Table V), independent of the order of presentation.

TABLE III

ANALYSIS OF VARIANCE FACTORIAL DESIGN (3 x 2 x 2) SORTING TEST RESULTS FOR 1) SIMPLE FIRST AND 2) COMPLEX FIRST RETARDED, NORMAL MENTAL AGE AND NORMAL CHRONOLOGICAL AGE GROUPS

SOURCE OF VARIATION	SS	df	MS	F
Between Ss	551.25	149	3.69	
Between Orders	.97	1	.97	.296
Between Groups	149.54	2	74.77	22.79***
Order x Groups	28.84	2	14.42	4.40*
Error	371.90	144	3.28	
Within Ss	113.00	150	.75	
Between Tasks	19.77	1	19.77	39.54***
Tasks x Order	.25	1	.25	.50
Tasks x Groups	16.00	2	8.00	16.00***
Tasks x Order x Groups	4.48	2	2.24	4.48*
Error	72.50	144	.50	

* Significant at the .05 level of confidence.
** Significant at the .01 level of confidence.
*** Significant at the .001 level of confidence.

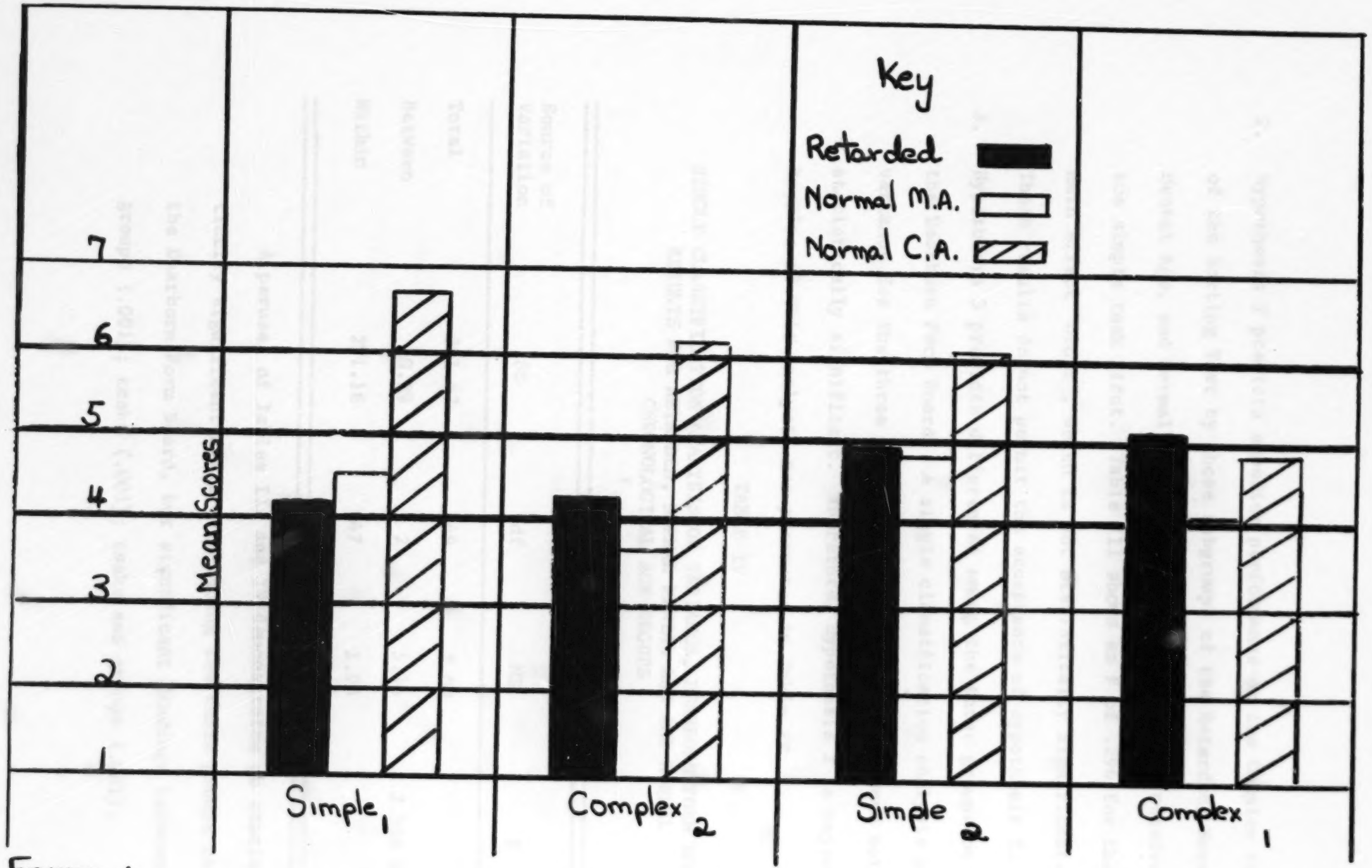

Figure 1. Mean Scores for Retarded, Normal M.A. and Normal C.A. Groups on Sorting Test

2. Hypothesis 2 predicts superior performance on the Complex task of the Sorting Test by those subgroups of the Retarded, Normal Mental Age, and Normal Chronological Age girls which received the simple task first. Table III shows an F of .296 for the main effect "order", which is not statistically significant. These results do not permit the acceptance of Hypothesis 2.
3. Hypothesis 3 predicts differences among the three groups on the Dearborn Form Board. A single classification analysis of variance for the three groups yielded results which were not statistically significant. Therefore, Hypothesis 3 is rejected. Results of this analysis are presented in Table IV.

TABLE IV

SINGLE CLASSIFICATION ANALYSIS OF VARIANCE, DEARBORN FORM BOARD RESULTS FOR RETARDED, NORMAL MENTAL AGE AND NORMAL CHRONOLOGICAL AGE GROUPS

Source of Variation	SS	df	MS	F
Total	301.47	149	2.02	
Between	10.29	2	5.14	2.596 N.S.
Within	291.18	147	1.98	

A perusal of Tables III and IV demonstrates no statistically significant differences among the three groups on the Dearborn Form Board, but significant findings between groups (.001); tasks (.001); tasks and groups (.001);

order and groups (.05); and tasks and order and groups (.05) on the Sorting Test results. It should be noted, however, that the two double order and one triple order interactions are all affected by the highly significant F (.001) obtained on the main effect "Group". "Order", apparently, is the depressing factor affecting the significant differences. This is further substantiated by noting the absence of statistical significance in the tasks and order interaction in spite of the highly significant F (.001) resulting from the main effect "Task". From these results it may be concluded that, whether the presentation of the Simple task preceded or followed the Complex, the results were not materially affected. Noteworthy, of course, are the highly significant differences demonstrated on the main effects "Groups" and "Tasks".

4. Separate t and F ratios were computed for the following:

   a. Retarded Simple task first and Normal Mental Age Simple task first;

   b. Retarded Complex first and Normal Mental Age Complex first;

   c. Retarded Simple second and Normal Mental Age second;

   d. Retarded Complex second and Normal Mental Age Complex second.

   Further analyses included t-and F-tests for:

   e. Normal Mental Age Simple first and Simple second;

   f. Normal Mental Age Complex first and Complex second;

   g. Retarded Simple first and Simple second;

   h. Retarded Complex first and Complex second.

Results of these analyses showed a significant difference beyond the .01 level of confidence between Retarded and Normal Mental Age subgroups receiving the Complex task first and between groups receiving the Complex second; an examination of the means shows the Retarded subgroups superior in both instances. Other analyses between Retarded and Normal Mental Age groups demonstrated no significant differences. It should be noted that the Normal Chronological Age group was not included in this part of the analysis.

Comparison of Simple first and Simple second, Complex first and Complex second subgroups of Retarded subjects yielded significant differences beyond the .05 level of confidence (see Table V). Normal Mental Age subgroups did not demonstrate significant differences between these variables.

5. Results of the Dearborn Form Board are presented in Table VI in terms of the number of correct moves per formboard and mean number of correctly completed formboards. Mean scores are tabulated for each of the major populations: Retarded (50 girls); Normal Mental Age (50 girls); and Normal Chronological Age (50 girls).

A perusal of Table VI shows a lack of any large discrepancies among the mean performances of the three groups on any of the individual formboards comprising the Dearborn test. Whereas the Retarded group surpasses the other groups in performance on

TABLE V

DIFFERENCES BETWEEN SIMPLE AND COMPLEX TASK SUBGROUPS OF RETARDED AND NORMAL MENTAL AGE POPULATIONS ON THE SORTING TESTS

TASK	GROUPS					
	Retarded		Normal Mental Age		F	t
	$\bar{X}$	σ^2	$\bar{X}$	σ^2		
Simple first	4.32	1.66	4.52	.97	1.71	.854
Complex second	4.40	1.92	3.52	2.73	1.42	2.829**
Simple second	4.88	1.79	4.84	1.57	1.14	.151
Complex first	5.08	1.43	4.16	2.45	1.71	3.239**
Simple first			4.52	.97	1.62	1.391
Simple second			4.84	1.57		
Complex first			4.16	2.45	1.15	1.951
Complex second			3.52	2.73		
Simple first	4.32	1.66			1.08	2.089*
Simple second	4.88	1.79				
Complex first	5.08	1.43			1.34	2.575*
Complex second	4.40	1.92				

*Significant at the .05 level of confidence.
**Significant at the .01 level of confidence.

item No. 1, the Normal Chronological Age group demonstrates its superiority on the higher level items. This is in accordance with the original expectation since the formboards are purportedly established in order of progressive difficulty. Both

TABLE VI

MEAN SCORES FOR RETARDED, NORMAL MENTAL AGE, AND NORMAL CHRONOLOGICAL AGE GROUPS ON DEARBORN FORM BOARD

GROUP	FORM NUMBER 1	2	3	4	5	6	7	8	Total Number Correct
Retarded	.84	.72	.48	.36	.20	.16	.08	.06	2.82
Normal Mental Age	.78	.78	.62	.54	.10	.26	.00	.06	3.18
Normal Chronological Age	.76	.72	.64	.58	.30	.26	.06	.16	3.46

Normal groups surpassed the Retarded on the number of correctly completed boards.

6. Table VII shows the mean number of moves utilized by the three groups in the completion of the following formboards: 1 through 4; 1 through 5; 1 through 6; 1 through 7; and 1 through 8.

TABLE VII

MEAN SCORES FOR RETARDED, NORMAL MENTAL AGE, AND NORMAL CHRONOLOGICAL AGE GROUPS ON COMBINED ITEMS OF THE DEARBORN FORM BOARD

GROUP	FORM NUMBER 1 - 4	1 - 5	1 - 6	1 - 7	1 - 8
Retarded	20.84	29.38	39.06	49.98	61.44
Normal Mental Age	20.30	29.84	38.40	50.58	62.34
Normal Chronological Age	20.08	28.50	38.10	46.44	59.72

Whereas the Retarded and Normal Age groups demonstrated collective mean results which were very similar, the Normal Chronological Age group exhibited the lowest mean number of moves for completing each of the collective categories. This trend lends support to the assumption that the higher mental age level, characteristic of the Normal Chronological Age group, has a direct effect upon the higher performance exhibited on the Dearborn Form Board.

7. For the Sorting Test, the separate grouping items (shape, color, edging, texture, height, symbol shape, symbol color, and symbol location) were ranked according to ease of solution. This was accomplished for each of the major groups, Complex first and Complex second, by computing:

   a. The largest number of sortings selected first,

   b. The largest combination of first and second sortings,

   c. The largest sum of first, second, and third groupings--progressively following this sequence through the last (eighth) grouping. Table VIII presents the rank order of subtests chosen by each of the major groups and a combined ranking for all three populations.

It can be seen in Table VIII that no large discrepancies in rank exist among the groups for the various item solutions. Whereas it was assumed a priori that the ranks would follow the items in the order originally listed, one significant deviation resulted: "Symbol shape" was ranked first for the combined groups.

TABLE VIII

RANK ORDER OF SOLUTIONS FOR ITEMS OF THE SORTING TESTS ACCORDING TO RETARDED, NORMAL MENTAL AGE, AND NORMAL CHRONOLOGICAL AGE GROUPS

GROUP	SHAPE	COLOR	EDGING	TEXTURE	HEIGHT	SYMBOL SHAPE	SYMBOL COLOR	SYMBOL LOCATION
Retarded	5	2	4	3	6	1	7	8
Normal Mental Age	3	2	5	4	7	1	6	8
Normal Chronological Age	5	1	3	4	6	2	7	8
Combined Rank	5	2	4	3	6	1	7	8

With the further exception of item "Shape", ranked fifth collectively, the remaining items approximated the preconceived rank order.

8. Hypothesis H_4, stating that there will be no observable differences between the performances of Normal and Educable children of the same mental ages on IRA Primary Mental Abilities Test concerned with reasoning was tested in a number of ways.

   a. When the differences between the means for the Total Reasoning Scores for the total Normal and Retarded groups was tested for significance, it was found that the probability of a difference of the magnitude found was greater than the 5 percent level. The difference was not a significant one, Table IX. Similarly, tests of significance were calculated

for R_w (Reasoning-Words) and R_f (Reasoning-Form between the means of the total Normal and Retarded groups. In neither instance were the differences between these means significant. The hypothesis, therefore, as far as the total groups were concerned, could not be rejected.

TABLE IX

COMPARISONS OF MEAN SCORES OF TOTAL NORMAL AND RETARDED GROUPS ON SRA PRIMARY MENTAL ABILITIES TEST - R (REASONING), R_w (REASONING-WORDS), AND R_f (REASONING-FORM) N=30

TEST	NORMAL	RETARDED	D/MEANS	t	PROBABILITY
R	115.33	112.33	3.00	0.72	$>.05$
R_w	112.93	111.20	1.73	0.36	$>.05$
R_f	119.40	116.00	3.40	0.75	$>.05$

b. To further test the hypothesis, comparisons were made of the various mean SRA Primary Mental Abilities Test Reasoning scores for Normal *and Retarded boys and girls,* Tables X and XI. It was found that the Normal boys scored

TABLE X

COMPARISONS OF MEAN SCORES OF NORMAL AND RETARDED BOYS ON SRA PRIMARY MENTAL ABILITIES TEST - R (REASONING), R_w (REASONING-WORDS), AND R_f (REASONING-FORM) N=15

TEST	NORMAL	RETARDED	D/MEANS	t	PROBABILITY
R	113.07	102.53	10.54	4.27	$<.01$
R_w	115.20	101.33	13.87	4.31	$<.01$
R_f	118.00	107.60	10.40	3.25	$<.01$

consistently and significantly higher than the Retarded boys on R (Reasoning), R_w (Reasoning-Words) and R_f (Reasoning-Form), Table X. The Retarded girls scored higher than the Normal girls on each of the Reasoning tests, Table XI. The differences were not significant.

The reversal in direction of difference for the boys' and girls' groups would account for finding no significant difference between the total groups.

TABLE XI

COMPARISONS OF MEAN SCORES OF NORMAL AND RETARDED GIRLS ON SRA PRIMARY MENTAL ABILITIES TEST - R (REASONING), R_w (REASONING-WORDS), AND R_f (REASONING-FORM) N = 15

TEST	NORMAL	RETARDED	D/MEANS	t	PROBABILITY
R	117.60	122.93	5.33	1.93	>.05
R_w	115.20	121.07	5.87	1.88	>.05
R_f	120.80	124.40	3.60	1.15	>.05

9. The data to test hypothesis H_5 is summarized in Table XII. In no instance was the difference between the mean Reasoning scores of the Normal boys and girls significant, although the

TABLE XII

COMPARISONS OF MEAN SCORES OF NORMAL BOYS AND GIRLS ON SRA PRIMARY MENTAL ABILITIES TEST - R (REASONING), R_w (REASONING-WORDS), AND R_f (REASONING-FORM) N=15

TEST	BOYS	GIRLS	D/MEANS	t	PROBABILITY
R	113.07	117.60	4.53	2.15	<.05
R_w	110.67	115.20	4.53	1.96	>.05
R_f	118.00	120.80	2.80	0.89	>.05

difference between the means for R (Reasoning) approached significance, being between the 1 and 5 percent level. The

Normal girls did somewhat better than the boys on each of the Reasoning tests. The hypothesis that there will be no observable differences between the performance of Normal boys and Normal girls of the same mental ages on the SRA Primary Mental Abilities Test (Reasoning) could not be rejected.

10. The data used to test hypothesis H_6 is contained in Table XIII. The hypothesis stated that on the SRA Primary Mental Abilities Test (Reasoning), there will be no observable differences between

TABLE XIII

COMPARISONS OF MEAN SCORES OF RETARDED BOYS AND GIRLS ON SRA PRIMARY MENTAL ABILITIES TEST - R (REASONING), R_w (REASONING-WORDS), AND R_f (REASONING-FORM) N=15

TEST	BOYS	GIRLS	D/MEANS	t	PROBABILITY
R	102.53	122.93	20.40	6.71	$<.01$
R_w	101.33	121.07	19.74	5.14	$<.01$
R_f	107.60	124.40	16.80	5.25	$<.01$

the performances of Educable Retarded boys and Educable Retarded girls of the same mental ages. It was found that the Retarded girls scored higher than the boys on each Reasoning test (R, R_w, and R_f) and that the differences between the means were all significant at the 1 percent level or less. Thus, the hypothesis was rejected.

CHAPTER V

DISCUSSION

The Sorting Test utilized in the first part of this investigation is apparently the best measurement of reasoning ability in the battery of three tests used. This task appeared to correlate highest with the SRA Primary Mental Abilities (scattergram) on the specific factors isolated as measurements of reasoning. As anticipated, the Normal Chronological Age girls surpassed the Retarded and Normal Mental Age girls in performance on the Sorting Test. What was surprising, however, was the significantly superior performance on the Complex task exhibited by the Retarded groups over the Normal Mental Age groups, since the mean mental ages of these populations were similar. Apparently on the Complex task of the Sorting Test, chronological age has a more direct bearing on performance than does mental age. It is to be noted that, although the differences were not statistically significant, the Normal Mental Age girls did surpass the Retarded on the Simple task of the Sorting Test when it was presented first, but performed slightly lower than did the Retarded girls when the Simple task was presented second. Therefore, the Simple task did not seem to rely upon the chronological age factor but appeared to be most affected by mental age. Further light is shed upon this finding by an examination of the results demonstrated by the Retarded subgroups when compared for performance on the Simple and Complex tasks. When the Complex task was given first, the performance of the Retarded subgroup exceeded not only all of the mean

performances of the Normal Mental Age subgroups, but also their own mean Simple task results. The Complex task was identified as the more abstract of the two Sorting tests and it was hypothesized that the Normals would surpass the Retarded girls on this phase of reasoning. The reverse of this hypothesis was demonstrated. Since both subgroups (Retarded and Normal Mental Age) were administered the two tasks, in counterbalanced order, the superior performance displayed by the Retarded subgroups on the Complex task, without concomitant superiority on the Simple tasks, cannot be assumed to be directly related to population selection. The direct influence of chronological age upon the performance of three groups on the Complex task, then, is apparent.

The Squares Test was discarded due to administration difficulties and the Dearborn Form Board, although a stimulating and challenging task for all subjects, appeared to lack the sufficient differentiating qualities which were inherent in the Sorting Test.

It must be emphasized that the Retarded group used in this part of the study is representative of an institutional environment.. Any comparisons between their performance and the performance of public school children, without due consideration of the different environments, may lead to broad generalizations which are unfounded in fact. In addition to the probable differential effects of environment, another influencing factor must be considered. The State School retarded population has, over the years, been subjected to varied experimental situations. This experience has, no doubt, made this group somewhat "test-wise".

The comparisons of Reasoning abilities of Normal boys and girls and Retarded boys and girls were made with Public School Normal and Retarded subjects. This eliminated the restrictions outlined in the preceding paragraph in regard to the other reasoning studies that were carried out. Although the total Normal and Retarded groups did not differ significantly in regard to their mean mental ages and the mean scores of the various Reasoning tests (R, R_w, and R_f) contained in the SRA Primary Mental Abilities Test, some differences were found when analyses were made of the subgroups of boys and girls.

The Retarded boys scored significantly lower than the Normal boys on all of the Reasoning tests. This was not true, however, for the Normal and Retarded girls where no significant differences were found. This is in contradistinction to the earlier findings reported in regard to the Complex task. Since it was also reported that the Sorting Test (of which the Complex task was a part) "...appeared to correlate highest with the SRA Primary Mental Abilities...on the specific factors isolated as measurements of reasoning...", the explanation must be in terms of differences in populations - one being institutional, the other being public school. Another explanation may lie in the selection of the Normal groups. The group used on the Sorting Test was selected on the basis of results obtained on the California Mental Maturity Test while the other Normal group was selected in the same way as the Retarded group - on the basis of mental ages obtained on the 1937 Revision of the Stanford-Binet, Form L.

The significant differences in Reasoning ability shown between the Normal and Retarded boys (but not the girls) was further emphasized when the Reasoning abilities of Normal boys and girls and Retarded boys and girls were compared. No significant differences were found between the mean scores of Normal boys and girls while the differences between the mean scores of the Retarded boys and girls were significant in each instance. Thus, any differences in reasoning found between the total Normal and Retarded groups of children would be caused by the boys rather than the girls.

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